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OPERATION OF WHITNEY RESERVOIR DURING THE FILLING OF POWER POOL

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HYDRAULICS DIVISION

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OPERATION OF WHITNEY RESERVOIR DURING THE FILLING OF POWER POOL[1]

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SYNOPSIS

The Corps of Engineers dam and reservoir located on the Brazos River near Whitney, Texas, is designed for flood control and stream flow regulation in connection with hydroelectric power generation and other beneficial uses. During the initial impoundment operations of the reservoir, the Brazos River Authority released water from Possum Kingdom Reservoir, located upstream from Whitney Dam, for downstream appropriators and requested the Government to make simultaneous releases from its reservoir on a replacement basis. This helped to speed delivery of much needed water to downstream users by saving as many as six days in transportation time. During the summer of 1952, in the midst of a prolonged drought period when Possum Kingdom Reservoir level was low and power contracts did not permit the Brazos River Authority to draw down the storage excessively, the Government released on a loan basis about 50,000 acre-feet of water from the storage in Whitney Reservoir for use by downstream irrigators. This water, which has been credited by local interests in saving that season's rice crop, has since been replaced.

INTRODUCTION

Whitney Dam is located on the Brazos River about 442.4 river miles above its mouth. The reservoir formed by the dam lies about 38 river miles upstream from Waco, Texas, and about 245 river miles downstream from Possum Kingdom (Morris Sheppard) Dam. The Bosque River enters the Brazos between the Whitney Dam and Waco.

The Whitney project was authorized for construction by the Federal Flood Control Acts approved August 18, 1941, and December 22, 1944. The project is a multiple-purpose reservoir designed for flood control, stream flow regulation in connection with hydroelectric power generation, and other beneficial uses.

The project consists of an earthen embankment, concrete spillway, power plant, and appurtenances. The total length of the dam is 17,695 feet consisting of 1,674 feet of concrete dam, 7,820 feet of dikes, and 8,201 feet of earth fill. The dam is 167 feet high at the maximum point, and the crown of the earthen section is 34 feet wide. A state highway crosses the dam.

The spillway is provided with seventeen 40- x 38-foot tainter gates. Intermediate releases are made through sixteen 5- x 9-foot conduits located in the base of the spillway.

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The power plant is located on the right bank of the Brazos at the downstream face of the dam. Water enters the turbines through two 16-foot diameter steel penstocks. Two generators with 15,000 kw capacity each are provided.

Whitney Reservoir controls the flow from an area of 17,656 square miles. An additional 8,950 square miles of drainage area lying in the semi-arid High Plains of the upper Brazos River Basin is considered noncontributing. This area consists of numerous disconnected sink holes and a few streams ending in closed basins. The reservoir capacity at the top of the initial power pool, elevation 520.0, is 387,000 acre-feet. Flood control storage of 1,630,500 acre-feet is provided in the reservoir between elevations 520.0 and 571.0, top of gates. The sills of the tainter gates are set at elevation 533.0.

Construction of Whitney Dam was started in May 1947 and was sufficiently advanced to permit commencement of deliberate impoundment of water on December 10, 1951. The power plant was completed and power generation started June 25, 1953.

Possum Kingdom (Morris Sheppard) Dam is located about 245 river miles upstream from Whitney Reservoir and was designed for hydroelectric power generation. It is owned by the Brazos River Authority, an agency of the State of Texas. This project was first placed in operation in April 1941. The contributing drainage area above Possum Kingdom Reservoir is 14,098 square miles. The intervening drainage area between Possum Kingdom and Whitney is 3,558 square miles.

During the 10 years prior to construction of Whitney Dam normal releases resulting from Possum Kingdom power generation were used by downstream rice growers and other appropriators for irrigation, municipal, and industrial purposes. However, during periods of drought or heavy water demand when the normal power releases were insufficient to meet the needs, additional water up to the full generating capacity was usually released from Possum Kingdom to satisfy these requirments. The maximum rate of release through the turbines at Possum Kingdom is about 5,500 acre-feet per day. No releases are normally made Saturdays and Sundays, and other releases depend on power demand. Normal summer demand by downstream users is about 2,500 acre-feet per day. The time of travel at this rate between Possum Kingdom and Whitney averages between 4 and 6 days. It takes from 7 to 10 more days for this water to reach the users in the lower Brazos River Valley.

During Construction

The first regulation of stream flow at Whitney occurred when closure and diversion were being effected in May 1950. Low summer flow of the Brazos River above Waco serves as a supply for the Texas Power and Light Company plant at Waco, Texas, for use in connection with power generation. However, closure and diversion were commenced on May 20, 1950, on the recession side of a small flood so that at no time was there zero flow at Waco, and the reduction in discharge was hardly noticeable even though some feared stoppage of flow. There was sufficient inflow into Whitney Reservoir to permit capture of about 5,000 acre-feet, and effect diversion of the Brazos River flow through 12 of the 16 sluices in a period of about 24 hours. Runoff from the Bosque, just upstream from Waco, produced sufficient discharge to provide a minimum flow at Waco of about 300 second-feet for a period of one day--several times the requirements at Waco.

A minor operational problem occurred when all of the sluice gates had to be closed in order to stop the flow and to permit removal of scaffolding and cribbing and clearing of the stilling basin. This would have stopped all flow from Whitney and consequent flow at Waco. However, at the insistence of the Government, the contractor made arrangements with the city of Waco wherein the city was to release about 75 second-feet from Lake Waco on the Bosque River for use by the Texas Power and Light Company. On January 4, 1951, all of the 16 sluice gates at Whitney Dam were closed. Here again there was sufficient river flow made available to furnish all requirements at Waco. After clearing of the stilling basin, all of the gates were opened and remained open until December 10, 1951, when diliberate impoundment was started in Whitney Reservoir.

In addition to the Texas Power and Light Company's water rights at Waco, there are several large appropriators on the lower Brazos River below Whitney Dam using large quantities of water for irrigation and for municipal and industrial purposes. The power company has water rights for only 100 second-feet, while the aggregate demand for irrigation and other uses downstream from Whitney Reservoir is in excess of 2,000 acre-feet daily. Prior to commencement of deliberate impoundment at Whitney Reservoir, these demands created no problem since all the gates were open and outflow from the reservoir was equal to the inflow.

After Commencement of Deliberate Impoundment

Commencement of deliberate impoundment in a reservoir does not imply completion of the project and its availability in full for its planned uses. This was true at Whitney. The area in the general vicinity of the project was experiencing a period of rainfall deficiency and lack of run-off at the time when construction was sufficiently advanced to permit deliberate impoundment on a limited basis. For a period of about two years the reservoir was thus operated with storage limited to gradually increasing levels. Plans were altered from time to time to permit storage and regulation of flood waters under various conditions.

After all of the gates at Whitney were closed and impoundment of water was begun on December 10, 1951, there were several short periods when stream flow on the lower river was not sufficient to satisfy irrigation and industrial demands. The downstream appropriators then requested the Brazos River Authority to make releases from Possum Kingdom Reservoir especially for them in accordance with their contractual agreements. Since about 12 to 15 days are required for releases from Possum Kingdom Reservoir to reach water users in the Gulf Coast region, a reduction in this delay of delivery of water was desirable. The Brazos River Authority therefore approached the Government and requested its cooperation in making releases from Whitney Reservoir on a concurrent replacement basis; i.e., Whitney and Possum Kingdom were to begin releasing simultaneously from both reservoirs. The arrangements were for the Authority to continue releases after Whitney had stopped in order to replace all water released from Whitney Reservoir in excess of its normal use and evaporation. The Government agreed to these "current" arrangements and each time water so released was replaced in Whitney Reservoir after allowing for evaporation and other normal losses.

During the spring and early summer of 1952 Possum Kingdom had exhausted its power storage, and any further irrigation drafts on the reservoir would have severely affected power contracts in effect with using agencies.

At the same time, however, the drought was severe and water was badly needed for irrigation in order to save the rice crop on the lower river. The irrigators continued their demands for releases from Possum Kingdom.

In the meantime, however there was little or no natural run-off between Possum Kingdom and Whitney Reservoirs, and Lake Waco on the Bosque was at critical stage. There appeared no hope for rain and additional run-off. At this time the storage in Whitney Reservoir was even less than required to conduct minimum head tests on the turbines prior to their acceptance by the Government. However, in order to insure uninterrupted power production by the Texas Power and Light Company plant at Waco, sufficient water was released by the Government from Whitney Reservoir to provide cooling water to keep the generators working at Waco. In order to mimimize waste and capture water so released the power company cooperated by ditching the river at its intake, diking and sandbagging. The water in storage at Whitney Reservoir was captured during floods in the spring and would have gone into the Gulf of Mexico unused and wasted, had it not been stored in Whitney Reservoir.

Late in the season the Brazos River Authority approached the Government and requested a "loan" of about 50,000 acre-feet of water from Whitney Reservoir for use by the irrigators on the lower Brazos River. This water was to be replaced by releases from Possum Kingdom Reservoir after January 1, 1953. The Government agreed to cooperate, with the consent of the Texas State Board of Water Engineers, the state's regulatory body on water matters. Proper clearances were obtained from the Chief of Engineers, Corps of Engineers, Department of the Army, and the Board of Water Engineers; and on August 17, 1952, the Government commenced releases from Whitney Reservoir on "Credit" basis and prearranged schedule. By September 9, 1952, a total of 51,900 acre-feet of water was released from Whitney Reservoir on this basis. The operation was a success. The entire $5,000,000 rice crop was saved, and both growers and laymen alike appreciated the fact that flood waters captured by Whitney Reservoir in April saved a valuable crop in September in the lower river.

The storage in Whitney at the beginning of this operation would have been 119,700 acre-feet (elevation 493.5), had all water released on concurrent basis been replaced in the reservoir. When the operation was completed, Whitney Reservoir was at elevation 482.2, storage 64,100 acre-feet—about 7,400 acre-feet was lost during this period by evaporation.

CONCLUSION

For nearly a whole year—fall and winter 1952, spring and summer 1953—there was not sufficient flow in the Brazos River above Possum Kingdom Reservoir to permit the Brazos River Authority to pay back the water released from Whitney Reservoir, nor was there enough flow below Possum Kingdom to fill Whitney storage to the top of the power pool, elevation 520.0. Small amounts of run-off did occur, however, but these served only to replace evaporation, losses, satisfy current demands for cooling water, and to build up head and storage previously lost in Possum Kingdom Reservoir.

Early in August 1953—one year later—several small floods above Possum Kingdom Reservoir generated sufficient run-off to assure a nearly full reservoir and permit repayment of 50,000 acre-feet to Whitney Reservoir. This was done between the middle of August and through September at rates favorable for power generation at Possum Kingdom. On October 11, 1953, the Government received the last of the water released on loan basis from Whitney Reservoir for the Brazos River Authority and the books were closed.

PROCEEDINGS PAPERS

The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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c. Discussion of several papers, grouped by Divisions.

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